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A SEARCH FOR X RAYS FROM UV CETI FLARE STARS

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A search of the MIT/OSO-7 data has been made for evidence of x-ray emission from flares of UV Ceti flare stars. Observations from McDonald Observatory have been used to identify the times of optical flares. The only instance of coincident coverage occurred on 1974 January 21 UT at 03:43:26 GMT for a $\Delta m_u = 0.86$ flare of YZ CMi. No radio coverage of this particular event was obtained. Upper limits (3σ) of 0.8, 1.0, and 0.7 photons/cm^2-sec on the observed x-ray flux have been set for the energy ranges $\gtrsim 15$, $\gtrsim 3$, and 1-10 keV, respectively.

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1. Observations. A search has been made for evidence of x rays from flares of UV Ceti flare stars using observations from McDonald Observatory to identify the times of optical flares. The MIT/OSO-7 x-ray data have been scanned, and only one instance of coincident coverage has been found. An optical flare of YZ CMi was observed on 1974 January 21 (UT) at 03:43:26 GMT with an excess luminosity corresponding to Δm_u=0.86. No radio coverage of this particular event was obtained. The MIT/OSO-7 data provide coverage for the two consecutive 3-minute periods beginning at the onset of the flare, but no coverage immediately prior or subsequent to this interval. No x-ray signal above background was observed in any of the energy ranges spanned by the MIT/OSO-7 detectors. In Table 1, the 3σ upper limits on the x-ray emission during the 3-minute period at the onset of the flare are presented.

Earlier predictions of x rays from UV Ceti flare stars have been summarized by Crannell et al. (1974). Each of these was based on a Δm_V=1 flare of UV Ceti. In order to relate these predictions to a Δm_u=0.86 flare of YZ CMi, scaling factors must be applied to compensate for the difference in the excess optical luminosity during the flare ($\sim$ 0.8) and the difference in the squares of the distances ($\sim$ 0.16), or a net factor of 0.13. The predictions scaled by this factor are presented in Table 1. Because no radio coverage was obtained for this event, the predicted fluxes based on the ratio of the solar x-ray fluxes to the solar radio fluxes are quite uncertain, relying solely on the association of a 10 Jy radio flare with a Δm_V=1 flare of UV Ceti. While upper limits in the present work are lower than any previously reported from direct measurements, they do not

definitively distinguish between the predictions based on the scaled solar-flare observations. They do, however, rule out a simple extrapolation of Grindlay's model (1970) to energies below 10 keV. Grindlay's model predicts fluxes 10^3 to 10^7 above those based on solar radio and solar optical scaling, respectively, for energies above 10 keV.

Table 1. Upper limits and Predictions

X-ray Energy (keV)	Description	X-ray Flux at Earth Photons/cm^2-sec
	3σ Upper Limits on the X-ray Emission from a Δm_u=0.86 Flare of YZ CMi	
> 15	MIT/OSO-7 Xe + Kr	0.8
> 3	MIT/OSO-7 Xe + Kr + Ar	1.0
1-10	MIT/OSO-7 Ar + Ne	0.7
	Predicted X-ray Emission from a Δm_u=0.86 Flare of YZ CMi	
> 10 1.6 - 12.4	Scaling model based on the ratio solar x ray/solar optical Kahler and Shulman (1972)	3×10^{-8} 10^{-3}
> 10 > 4.1 1.6 - 12.4	Scaling model based on the ratio solar x ray/solar radio Crannell *et al*. (1974)	3×10^{-4} 0.1 5
> 10	Synchrotron model Grindlay (1970)	0.3

The gas-filled proportional counters with 3° collimation employed in the measurements reported here have been described by Clark *et al*. (1973).

2. Discussion. The significance of results such as those reported here is limited by the variability in the types and relative intensities of stellar flares and the variability in the relative onset timing. Spangler and Moffett (1975) have recently completed simultaneous observations of more than 62 UV Ceti-type flares, and have found no significant correlation between optical and radio flare intensities. In correlating the starting times of the events, they find delays of up to $\pm$ 10 minutes of the optical flare relative to the radio. For the event considered in the present work, the lack of x-ray coverage prior to the onset of the optical flare allows the possibility that an x-ray burst preceeded it. Extended coincident coverage would greatly facilitate the interpretation of future measurements.

Not only are more coincident observations needed to identify the types of stellar flares, but increased x-ray sensitivity is also needed to distinguish between various flare models. Several aspects of the events observed by Spangler and Moffett suggest that the radio emission mechanism is coherent synchrotron radiation, favoring models such as the one developed by Grindlay. The great variability in the relative intensities of optical and radio emission could be explained by beaming. Future observations, especially those incorporating simultaneous x-ray, radio, and optical coverage will help to develop our understanding of the flare emission mechanisms.

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